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ABSTRACT

Addition of fiscal response factors to the traditional simulation model of school finance demonstrates that the traditional model underestimates both the costs and impacts of state aid programs at the district level. The study reviews research on fiscal response--defined as school districts' taxing and spending behavior after receipt of state aid--and extends the fiscal response analysis both by measuring fiscal response over two-year (instead of one-year) periods, using three different statistical methods; and by adding to the fiscal response equations the effects of geographic cost differences, local noneducational spending, and school district wealth and income. Combining the augmented fiscal response equations with the traditional simulation model of school finance allows one to predict individual school districts' responses to state aid programs. Applied to New York State data, the combined model shows that low-income districts spend a greater proportion of state aid on education than high-income districts, and that the traditional model underestimates district spending increases in response to state aid as well as the impact of state aid on equity goals and the costs of New York's "percentage equalizing" method of financial aid. (Author/RW)

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Fiscal Response and School Finance Simulations: A Policy Perspective

Education Finance Center
Education Commission of the States

Fiscal Response and School Finance Simulations: A Policy Perspective

Report No. F80-3

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Executive Summary

Much effort has been made to estimate the impact of revised school finance programs. This includes extensive research on school district taxing and spending behavior, or fiscal response, as well as the development of traditional school finance simulations. The research on fiscal response has revealed increasing statistical and conceptual complexities. The development of simulations, on the other hand, utilized only simple response models and therefore provided less than precise descriptions of the likely impacts of new programs statewide and in individual school districts.

This study summarizes research on fiscal response to date, and extends it along both statistical and conceptual dimensions. Differing statistical methods are used for two years of data for one state to measure fiscal response over time. Two conceptual issues are also treated in the present research. The first is the inclusion of an education inputs price index to account for cost differences. The second measures impact of the noneducation component of a district's budget on fiscal response.

The present study also uses the fiscal response equations in a simulation model to predict individual district response to the simulated school aid programs. The focus here is the ramification of the various estimates of fiscal response on the simulation results.

A major finding is that analysis over more than one time period indicates that on average, districts use more of additional dollars of aid for increased expenditures than one-year statistical analysis suggests. When these average response measures are used with individual district characteristics in the simulation process, several important findings emerge. First, the characteristics of the district affect their individual response. Low-wealth, low-income districts tend to use more of state aid to increase spending than high-wealth, high-income districts. Second, simple assumptions previously used in the simulation models can understate the impact of the program on certain equity goals. Finally, the costs of a power equalizing program, as opposed to a foundation type program, are underestimated in the simple simulations because they do not account for an interaction of spending behavior with the receipt of aid.

Introduction

How do school districts alter their taxing and spending decisions in response to the receipt of state aid? This issue has been thoroughly studied in recent years. This research on fiscal response has become more complex as sophisticated statistical and conceptual issues have been raised. Should response estimates be measured at one point in time or over a series of school years? Will the estimates differ dramatically if the data are adjusted for the geographical cost differences that exist? These and other questions have been addressed by various researchers studying fiscal response (Vincent and Adams, 1978; Carroll and Park, 1979; and Adams, 1979). One purpose of this study is to summarize previous research and provide supplementary analysis on new statistical and conceptual points.

The statistical analysis in this study includes cross-sectional, pooled cross-sectional, and first difference analysis for Wisconsin and New York school districts. The new conceptual work in this study includes analysis of fiscal response before and after adjusting for geographic differences in prices, and analysis of the impact of noneducation services purchased by school district residents on school district fiscal response.

Information gained from these new results has been used in conjunction with a traditional school finance simulation model. Previous simulations have not used estimates of fiscal response to determine how district spending and taxing decisions change as a result of various school finance reform proposals. This omission may give an inaccurate description of the estimated expenditure distributions that result with alternative school aid formulas. In particular, the equity of the distribution may be miscalculated. The present study explores a variety of ramifications of the inclusion of statistically estimated fiscal responses in a simulation model. One focus is the impact of these fiscal response estimates on the equity measures predicted by the simulation process.

Some earlier simulations have postulated a range of plausible responses and in the actual simulation process, assumed a median response for all school districts. A refinement included in this study is the estimation of a fiscal response for each individual school district. Fiscal characteristics, such as resident income, that

affect how districts respond to increased state aid are included. This refinement becomes more complex when the statistical and conceptual issues surrounding fiscal response estimates are considered. Are the simulations significantly different when fiscal response is measured in one year or over a series of school years? The second purpose of this study is to gauge the sensitivity of simulation results to the various statistical and conceptual issues of fiscal response research.

The present simulations are limited to describing expenditure distributions at one point in time for the school districts of New York. This provides a basis for the development of other simulations that could be used to predict expenditure distributions in future years. These predictions would require more attention to trend analysis of all critical factors, such as district property values, household income levels, pupil growth rates, state aid and so forth. This will remain the task of future work.

The present study constitutes an advance in that it integrates substantive fiscal response research into a well-developed state simulation model. It provides a more accurate description of the *pattern* of spending among school districts that alternative school aid formulas are likely to evoke. Since the pattern of spending among low and high wealth districts and for city and noncity districts is the focus of court decisions, this step significantly aids policy evaluation.

This study is presented in five major sections. Section I provides a brief overview of a model of fiscal response and results of recent research are given. The second section summarizes the conclusions of previous *and* present fiscal response studies on several statistical and conceptual issues. The third section briefly describes the nature of a school finance simulation and discusses its strengths and weaknesses. Section IV presents the results of the present simulations for one particular aid program in New York. The final section, Section V, summarizes the policy implications of the fiscal response research and its incorporation in the simulations. The focus in this final section is the policy issues and statements that can be made with the variations in fiscal response/simulation models. Directions for future research are included. Supporting statistical tables and printouts that display summaries of pertinent simulations are included in Appendices A and B. Appendix C provides a glossary of terms used within the text.

I. Review of Fiscal Response Model and Findings

In order to understand the more complex issues emerging in fiscal response research, it is important to understand the underlying model used in analyzing fiscal response. Fiscal response of school districts simply refers to their taxing and spending behavior. This behavior is viewed as nothing more than the median behavior of individuals that reside and vote in that district. The essence of the model is that this behavior can be explained by factors which traditional economic analysis contends affect any spending decision: income or wealth, prices, and tastes and preferences. The measures of these factors in the statistical analyses reflect the particulars of the school finance environment. For example, the "price" is often a measure of the share of total taxes borne by the representative voter.

The contention of the basic fiscal response model is that individuals choose that level of education services that brings the most satisfaction to the community, given their income and wealth, tastes and preferences, and the relative prices of education services. There are two major sources of revenue to the district to purchase this desired level of services: locally-raised tax revenues and aid from state or federal governments. When this model is translated into statistical analysis, both the average level of community personal income and these intergovernmental aids are included as explanatory variables. The statistical equations quantify the response, in terms of taxing and spending, average personal income, intergovernmental aid, as well as local property wealth, "price" factors, and socioeconomic factors believed to describe resident tastes for education.

The model is also used to construct hypotheses, or expected results, in the statistical analysis. For example, higher levels of property wealth and/or personal income are expected to result in higher education expenditures per pupil. Each dollar of state aid is expected to have a positive but less than a dollar impact on increased expenditures. It is hypothesized that a portion of each dollar of state aid is used to purchase other items, via tax relief. The hypothesized impact of any "price" factor on education expenditures is negative. The higher the price of education

services, the less individuals are willing to vote for and purchase. There are several components of the "price"[1] of education services tested in the present statistical equations. Finally, the expected impact of certain taste variables are derived from the model. Districts that have higher education levels of the adult population are expected to value education more and tend to vote for higher expenditures per pupil, all other factors held constant.[2]

Most researchers (Feldstein, 1975; Ladd, 1975; and Lovell, 1978) use only a total revenue (expenditures) equation to test the theoretical implications of this model. This focus only provides information about the sum of local, state and federal revenues. Two earlier studies (Vincent and Adams, 1978; Adams, 1979) as well as the present effort analyze expenditures financed solely from locally-raised tax revenues. Using both equations enables one to analyze the entire system of revenues more thoroughly. The total revenue equation includes the use of outside revenues such as state and federal aid; this aid is intentionally distributed to change the relationship of revenue to wealth that would otherwise exist. The local revenue equation reflects only those revenues raised by local taxing decisions and is perhaps more reflective of the district resident's ability and willingness to raise revenues.

Several conclusions are common to the many studies of fiscal response. First, both property wealth and a measure of current household income have significant positive impacts on the levels of revenues raised by school districts. Furthermore, the residential and nonresidential components of the property tax base have different impacts on spending decisions. Specifically, the district with relatively more nonresidential property will tend to raise more revenues for education services. Finally, all authors estimate that the impact on expenditures of an increase of a dollar in general state aid is less than a dollar. That is, there is a tendency

[1] Earlier studies (Ladd, 1976) have primarily tested the impact of the price effect of nonresidential components of the property tax base. If voters perceive they can export property taxes, the perceived price in terms of additional tax dollars, is lower in school districts with a higher proportion of commercial industrial property (Ladd, 1975). Another estimated price effect (Ladd, 1975; Adams, 1979) is the price inherent in a matching grant formula such as a Guaranteed Tax Base program. For example, when the state matches local revenues under such a program, the price of an additional dollar of revenue to the school district is only $0.50. Any of these price factors affect the share of total taxes borne by the representative voter.

[2] The statistical analysis used to test this model uses a number of independent factors believed to influence the level of education spending. The value of such a multivariate analysis is that it separates out the independent effects of each factor. For example, the influence of property value alone, holding income, tastes and prices constant, is measured.

for some aid to find its way into local tax relief. On the other hand, the impact of a dollar of state or federal categorical aid is close to a dollar and sometimes above, i.e., stimulative of additional effort.

An ECS study that compares fiscal response estimates among four states (Adams, 1979) draws the above conclusions for each state but finds the relative importance of wealth and income somewhat different among the states studied. This study also confirms a low response to the "price" inherent in a matching grant school-aid formula found earlier (Carroll and Park, 1979). The response to the "price" is generally measured in terms of an elasticity.[3] The measure of this price elasticity for Colorado was approximately −0.10 and for Wisconsin districts, −0.20 (Adams, 1979). This means that a 50 percent reduction in the "price," from an increase in the matching rate of the formula, would increase expenditures in Colorado by 5 percent and in Wisconsin by 10 percent.

The estimates in these two states and Michigan of −0.02 (Carroll and Park, 1979) are in stark contrast to those for Massachusetts, −0.91 to −1.60 (Feldstein, 1975). These earlier results by Feldstein pointed to the use of a matching grant formula to stimulate local education expenditures, via the "price" incentive. Only a 10 percent reduction in price would be needed to stimulate expenditures by 16 percent. All estimates from more recent work, however, confirm the lower range of price elasticity estimates with corresponding implications for policy in matching grant formulas (Black, Lewis and Link, 1979).

Another important conclusion from this four-state comparison is the apparent sensitivity of fiscal response to the overall structure of the state's school finance system. The matching aid structure of the Guaranteed Tax Base Program (GTB) in Wisconsin results in less additional spending per dollar of aid (approximately $0.20) than Maryland's nonmatching aid (approximately $0.50).[4] Maryland is the only state among the four that has no type of expenditure limitation. The matching formulas in Kansas and Colorado are effectively constrained by spending limitations resulting in even less additions to spending with state aid.

Two recent studies (Lovell, 1978; Black, Lewis and Link, 1979)

[3] An elasticity is a measure of the degree of responsiveness. Specifically, it is the percentage change in the dependent variable with a one percent change in the independent variable, in this example, the "price" variable.

[4] These dollar examples are derived at the sample mean and are *not* indicative of any one individual district.

analyze the fiscal response of Connecticut and Delaware school districts. Both studies dwell on the effect of "price" factors on school district spending. Lovell concludes that not only the *level* of household income but also its *distribution* affects school district expenditure decisions via the tax price. The more unequal this distribution, the lower is the perceived tax price to the resident voter, and the greater is the level of revenues for education services. The analysis of Delaware districts, again, confirms the set of factors that affect district taxing and spending decisions. The authors' major conclusion is that the low response to the "price" factor found in Delaware would indicate high negative matching rates (recapture) for a school aid formula of that type to be effective in reducing wealth related expenditures.[6]

Each of these studies has served to confirm the basic underlying model of school district decision making. The fact that many states have now been analyzed and that results have been markedly consistent among these states shows the strength of these assumptions.

Yet, the majority of these studies has relied on a traditional cross-sectional statistical analysis, i.e., analysis of just one year of school district data. There are some research efforts by earlier authors that test the fiscal response of school districts over a longer period of time. Their results and new analysis for Wisconsin and New York are discussed in the following section. Second, all of the previous studies of fiscal response accounted neither for geographic differences in the purchasing power of school district revenues nor the impact of noneducation expenditures. These issues are also treated in the following sections. The focus in the remainder of the booklet is the school district's response to state general aid after controlling for all other relevant factors. The measure of school district response to state aid is the crucial one for the use of the research results in a simulation model.

[5]These authors argue that the price effect of the matching rate in a school aid formula is equivalent to the price effect of the composition of the tax base. In some states, the impact of these two are statistically equivalent when measured in total revenue equations (Adams, 1979).

[6]Much of the reason researchers have focused on the price effect of school aid formulas is due to Feldstein (1975) who contends that states need only set the matching rate of the formula in precise relation to a broad measure of wealth in order to reduce the relationship of expenditures and wealth to zero.

II. Studies Addressing Statistical and Conceptual Issues

The analysis of school district taxing and spending behavior has become increasingly complex in recent years (Feldstein, 1975; Adams, 1979; Carroll and Park, 1979, and Adams, 1980b). These studies inevitably confront a set of statistical issues arising from the basic nature of the problem. The problem is one of measuring the spending response of individual districts as well as groups of school districts, as levels of state aid are changed. Analyzing differences among school districts calls for cross-sectional analysis while analyzing individual district changes in aid and spending calls for time-series analysis.[7] Time series data are expensive to develop, often not available and/or available for only a few years. Previous authors have used various statistical methods to handle this problem. A summary of these methods and additional results for Wisconsin and New York school districts are presented in this section.

In addition to these statistical issues, a range of conceptual issues surrounds the fiscal response problem. An analysis of some of these conceptual issues has been recently completed for New York districts.[8] One issue addressed by this research is the effect of variations in the price of education inputs on spending patterns. The taxing and spending decisions of school districts were found to be affected by these differences in prices of resources, such as teaching personnel. Another conceptual refinement in that analysis was the inclusion of a variable reflecting the levels of spending on other noneducation local public services. In certain school districts, such as those in urban areas, a very different menu of

[7] Cross-sectional analysis simply refers to statistical analysis that uses data on a number of districts at one point in time, such as all school districts within a state for a given school year. Time-series analysis, on the other hand, involves data over a series of years for either one school district or the entire group.

[8] This research constitutes part of an extensive set of studies on several issues in school finance that was undertaken for the New York State Task Force on Equity and Excellence in Education that was created after the *Levittown v. Nyquist* court decision. Research funds for the New York State Task Force on Equity and Excellence in Education were provided by the Ford and Spencer Foundations, the Carnegie Corporation, the National Institute of Education, The Education Commission of the States and the State of New York.

public services surrounds the spending decision for education services. The impact of this environment of education expenditures was tested.

Statistical Issues

The primary question school finance researchers attempt to answer in analyzing taxing and spending behavior of school districts is: "How do school districts respond in terms of local taxing and spending decisions when the amount and/or structure of state aid is altered? The best way to examine, for example, the impact of a particular fiscal change is to analyze data over a substantial period of time during which that fiscal change was the only significant event. However, such time periods seldom exist. The longer the time period, the more likely that significant structural changes, or other fiscal changes, occur. It is difficult, therefore, to obtain sufficient observations over time to adequately analyze the impact.

Using data for groups of school districts for one period of time, usually a school year, provides the amount and variance of data needed for good statistical analysis. The problem with this approach, however, is it assumes that the basic structure of all school districts, including factors such as their administrative and political organization, is the same. This obviously does not reflect reality. In addition, it is questionable whether this cross-sectional analysis of groups of districts in one time period answers the basic dynamic question of district response across different time periods.

Two statistical methods that overcome these problems can be applied to analyses of school district spending. One method is to use data that are "pooled." This means that several years of data on a group of school districts are combined, or pooled, for statistical analysis. This increases the variance of the data and allows the researcher to test the stability of results over a longer period of time. An earlier study of Michigan school districts (Carroll and Park, 1979) and the present study of New York and Wisconsin districts use both cross-sectional and pooled cross-sectional methods of analysis.

By using the pooled cross-sectional method in their study of Michigan districts, Carroll and Park addressed an issue that is statistical but also intuitive. The introduction of a GTB program in Michigan occurred within the time period studied and constituted a structural change for these districts. This could alter district

response to all factors that affect spending or only the "price" variable related to the GTB.

To test the hypothesis that one-year analysis of fiscal response is descriptive of actual behavior, Carroll and Park estimated an equation separately on several years (1971/72-1975/76) of cross-sectional data, then, on pooled data. The results were roughly consistent across years. In particular the "price" response was not significantly different from zero[9] in 1973/74 and significant but quite small (−0.15 and −0.19) in 1974/75 and 1975/76. When the data were pooled, overall results were comparable, but the measure of the price elasticity was even smaller, −0.02.

In addition, the response to the new price variable could be significantly different in the first year or two of the new plan than in subsequent school years. Carroll and Park tested this on the pooled data set. Their results indicated that school districts' response to the price variable was stable between prereform and postreform years as well as among postreform years (1973/74-1975/76).[10] In all years, districts displayed a very small spending response to the price incentives; lowering the price by 50 percent in Michigan would only increase education spending by one percent (Carroll and Park, p. 24).

Simple cross-sectional results for Wisconsin school districts imply a greater response to price than the similar analysis in Michigan. In Table A-7, the statistical measures of response on the price variable for Wisconsin is −.214; a 50 percent reduction in price for Wisconsin districts would increase spending by approximately 11 percent. When the data for the two school years (1973/74-1975/76) are pooled, the results are very consistent with the cross-sectional analysis, the price response equals −.210 (see Table A-8). When the data are pooled, moreover, the efficiency of the estimates is improved. That is, the statistical reliability of the estimates as evidenced by the t-statistics, becomes greater. Furthermore, the total variation explained is much higher, although a dummy variable for the second year's data is included, which also increases this statistic.

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[9] In regression analysis a statistic is included with each coefficient that indicates whether the coefficient is different from zero with a certain reliability. This relates back to the model's hypothesized relationship between each factor and the dependent variable.

[10] For detailed information on these statistical procedures, see Stephen J. Carroll and Rolla Edward Park, *The Search for Equity in School Finance: Michigan School District Response to a Guaranteed Tax Base*, R-2393-NIE/HEW (Rand Corporation, March 1979), pp. 18-28.

When the data for New York school districts are pooled for the 1975/76-1976/77 school years (Table A-4), the results are similar to the one-year cross-sectional analysis, but also indicate a greater use of aid. The pooled coefficient on general aid in the total revenue equation indicates an elasticity of .08, as opposed to earlier cross-sectional estimates that range between .04 and .07.

Another method used by researchers to address the question of cross-sectional versus time series analysis, is to use data in "change" form. That is, *changes* in spending levels between years are explained by *changes* in fiscal factors such as property wealth, resident income, pupil counts and levels of state aid.

Minnesota, Wisconsin and New York provide a good sample of school finance practice in the country since they represent states using a Foundation program (Minnesota), a two-tiered percentage equalizing program (New York) and a Guaranteed Tax Base program (Wisconsin) at the time of analysis.[11]

The results for Minnesota come from an earlier ECS study (Vincent and Adams, 1978) which included two years of cross-sectional analysis as well as changes between those two years (1972, 1976). Both forms of analysis indicated that only a portion of state aid increased total spending, but the amount appeared to be larger when measured over time, i.e., by the change method. Minnesota districts appeared to spend $0.28 to $0.41 of each additional $1 of state aid in 1972 and 1976, respectively, when the years are analyzed separately; the remainder, $0.72 to $0.69, being used to replace local tax revenues. When the variables were expressed in terms of changes between 1976 and 1972, the statistical analysis indicated districts spent approximately $0.49 of each dollar of aid, a slightly higher response, which implies only $0.51 was used for tax relief.

Both these methods of analysis were used for Wisconsin and New York school districts in this study. The results of the statistical equations are included in Appendix A. For New York school districts, the analysis using variables in "change" form indicates districts increase total spending per pupil by approximately $0.60 of each additional dollar of state aid (Table A-5), much higher

[11] This is an important distinction because of the different economic incentives created under each alternative formula. A Foundation program essentially increases the amount of income available to the community; it has an "income" effect. A Guaranteed Tax Base program alters the price, in terms of local tax dollars, for additional dollars of spending on education services; it has a "price" effect. Because of formula constraints, the New York formula operates as a two-tiered foundation plan that has an "income" effect.

than the cross-sectional results. The implied elasticity[12] from these results is .24, compared to an estimated elasticity of between .04 and .07 from cross-sectional analysis (see Tables A-1 through A-3). This analysis based on two time periods indicates that more aid is used to increase expenditures and less for tax relief than the single year analysis indicates.

An additional analysis of the "changes" between the two years for New York are presented in Table A-6. These equations allow the response to aid, income and property value to be different among districts located downstate (or the New York City metropolitan area) versus those upstate. The results indicate that downstate districts tend to use less of additional dollars of state aid for increased expenditures; the coefficients imply downstate districts use $0.05 out of each dollar as opposed to $0.68 for upstate districts. The results also indicate, though, that downstate districts tend to spend more out of additional dollars of personal income for education services than districts upstate. These findings strongly suggest that the individual characteristics of school districts affect their fiscal response to general state aid. Any statistical analysis of average behavior may vary significantly from individual district behavior.

An analysis of Wisconsin school districts that uses "changes" in variables between 1973/74 and 1975/76 also indicates a greater use of state aid for increased expenditures than the one year of cross-sectional analysis (Table A-10). The Wisconsin results are more difficult to interpret in dollar terms since the description of the school aid formula involves a price variable. The lower the price of revenues to the district, the more state aid they receive. The results in Table A-10 suggest that as the price is decreased by one unit (aid is increased), total spending increases by $31 per pupil.[13] This result is comparable to, but still higher than the results of cross-sectional analysis for the 1973/74 school year. In that year, a one unit lower price of revenues is associated with just $23 higher per pupil spending.

These statistical analyses using variables in "change" form provide results that are consistent with cross-sectional analysis, in either

[12]The elasticity measure reported in the above text is derived from the coefficient in Table A-5 of .592 and the sample means of equalization aid and total revenue per pupil. This is *not* indicative of any particular district's response.

[13]This requires calculating the dollar amount of aid needed to alter the price by one unit. Mean values on all factors included in the formula can be used but, again, this is not representative of any particular district.

linear or log-linear form[14] and for the states under study. One drawback of the "change" analysis, though, is that the total variation explained in the equations is low, particularly for Wisconsin districts. The local revenue equations in Tables A-5 and A-6 explain only approximately 37 to 42 percent of the variation in behavior. It would be difficult to rely on these particular equations given the mechanics of the present simulation model.[15] Yet they serve to confirm the reliability of statistical estimates using cross-sectional or "pooled" cross-sectional analysis. The estimates of response to general aid are somewhat different among these different econometric approaches. A very important finding is that when the response is measured over more than one time period, either by "change" analysis or "pooled" data, the estimate indicates more of each additional dollar of aid is used to increase expenditures.

Conceptual Issues

Earlier studies of fiscal response of school districts have not addressed two important conceptual issues: the true purchasing power of revenues raised by local school districts and the interaction of education spending with other local public sector services. The present study includes these refinements for New York school districts. This allows comparison of spending response measures from three conceptually different models.

Most analyses of school district spending behavior have analyzed data on revenue/expenditures actually raised by districts. As courts and decision makers well know, revenues raised do not necessarily reflect real inputs purchased or service levels provided. This is especially true if the purchasing power of school district revenues vary. An index of the variations of input prices is available for New York school districts (Wendling, 1980). Analysis of the fiscal response of New York school districts presented in Tables A-1 through A-6 includes data before and after adjusting for these geographic differences in prices.[16]

[14]When equations are estimated in log-linear form, all variables are expressed in terms of natural logarithms. The underlying relationship of the variables is assumed to be multiplicative rather than additive.

[15]The present model uses estimates of the residuals for individual districts' predicted values. The small amount of total variation explained and large standard errors for the equation could cause problems in the prediction process.

[16]In the text as well as the statistical tables, the term "nominal" refers to actual dollars of revenue raised. The term "real" refers to adjusted dollars.

The focus, again, is whether measures of fiscal response to general aid differ under different conceptual models, i.e., one with and one without the price adjustment. The statistical analysis for each of these models is only one-year cross-sectional analysis, due to limitations on data.

The analysis of nominal (nonprice-adjusted) revenues indicates that a one percent increase in state general aid increases education expenditures by .07 percent (Table A-1). When analyzed in real dollar terms (Table A-2), the response measure is lower, only .04 percent. The analysis in real dollar terms, therefore, indicates smaller increases in spending as aid is increased; approximately $0.10 of each real dollar of aid is spent as opposed to approximately $0.20 when the response is measured in nominal terms.[17]

A further step in the modeling of school district fiscal response is the inclusion of information on other public services provided in the area. Does the level of provision of necessary noneducation public services, such as police protection, affect the taxing and spending decisions of residents for local schools? The equations in Table A-3 include an additional independent variable that measures "essential" noneducation revenues per capita for each school district.[18]

The results indicate that education and noneducation services are positively related. It appears that when school district communities expand the local public sector, all components are involved. The measure of response to general aid in these equations is between the estimates of the two previous conceptual models, .07 in the nominal dollar equations and .04 in the real dollar

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That is, data on actual revenues are divided by the price index to better reflect real amounts of inputs purchased.

[17]This dollar example is calculated at the sample mean. This is not representative of any individual district. A better comparison of these two conceptual models is seen in the simulations when actual data on individual districts are used.

[18]These "essential" revenues are derived from a separate statistical analysis of the noneducation revenues. Various socioeconomic variables such as the crime rate and density of population were used to explain variations in these revenues. These results were used to predict the "essential" amount of revenues as if the district had average fiscal capacity but its actual socioeconomic characteristics. A full description of this analysis is provided in "Municipal Overburden: The Concept and Some New Evidence," E. Kathleen Adams, Working Paper No. 29 (Education Commission of the States, 1980a). The basic data on noneducation revenues were taken from Miner and Sacks (1980).

equations. A one percent increase in aid is associated with .05 percent higher spending; this translates into an expenditure of approximately $0.13 of each additional real dollar of aid on school expenditures.

The magnitude of measured response to general aid is somewhat different among these econometric and conceptual approaches. The persistent result, however, is that the effect of state intergovernmental aid is to partially displace local revenues raised for school purposes. The effect of aid on total spending is less than a dollar for each dollar of aid distributed. The importance of this funding for simulation models is that the distribution of new aid is not likely to alter spending patterns in a simple manner. It is important to include the *amount* of displacement of local revenues, as well as the *pattern* of displacement across types of districts, when simulating new aid formulas.

III. Simulation Models, Their Strengths and Weaknesses

Simulation models have been developed for a variety of uses from modeling corporate financial planning to describing changes in the national economy. Some models include only simple accounting statements while others involve hundreds of multivariate statistical equations. They have become an important tool in school finance by providing measures of the fiscal impact resulting from alternative school aid formulas.

These computer-based models combine individual school district data with the decision rule of a certain school aid formula to predict the amounts of state aid, local tax rates and expenditure levels for each school district in a state. More recent simulations include measures of expenditure equity and neutrality, and list changes in aid for all districts as part of the computer output. The fiscal impact of aid formulas for the entire state is also displayed, measured by average expenditure levels and predicted costs in terms of additional state revenues.

These simulations have helped legislators to make more informed decisions about alternative aid programs. They expand the number of options a state can consider, help gauge whether new programs diminish existing inequities, and provide measures of the fiscal impacts in several ways. Recent simulations in New York have also shown changes in the distribution of tax burdens that occur with changes in school aid. There is no question about the increasing sophistication and policy relevance of school finance simulations.

Yet the ability of simulations to predict individual district expenditures or the *distribution* of those expenditures relies on some assumption of school district fiscal response. Typically, the models assume districts will use all additional aid to increase expenditures or only some portion, say half, in increased spending. This is a limitation of present simulations since current research on this topic indicates that districts do change their taxing behavior as they receive outside aid. Furthermore, there are differences in this behavior across states and among districts within a state (Adams, 1979).

The ideal method for incorporating fiscal response behavior into simulation models would be to estimate school district fiscal behavior for each state under study. This would allow for individual state characteristics as well as individualized district response. It appears that other characteristics of the districts, such as average family income affect the impact of state aid; higher average incomes, for instance, could lead to greater spending increases with a dollar of additional aid.

In creating a fiscal response/simulation model, the researcher combines statistical analysis (regression)[19] with an otherwise static (algebraic) simulation model. This process can evoke a number of statistical and mechanical problems due to inherent limitations of both the statistical analysis and the simulation process.

The critical limitation of a fiscal response/simulation model that uses measures of response from statistical equations is the inability of those equations to predict *each* district's behavior precisely. A regression equation describes the average response for each group of districts with a given set of characteristics (i.e., independent variables). Inevitably, some districts lie above and some below this average. Because of this, regression equations will under- or overpredict for any one particular district. Earlier authors (Grubb and Michelson, 1974), who included statistical estimates of fiscal response in a simulation model, note that the prediction error for individual districts is likely to be greater than for the total distribution (p. 159). Their simulations were therefore described by summary statistics rather than isolating individual districts. In the simulations presented in this report, the "error" terms have been added back in so as to improve predictions for individual districts.[20] However, since total distributions are the focus of policy concern, description of present simulation results are also summary in nature.

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[19] Regression analysis refers to a statistical procedure that uses historical data observations on at least two variables. It is assumed that the independent variable causes changes in the dependent variable. An equation that best describes the relationship between the two variables is the result of the regression analysis.

[20] The error terms are simply the unexplained portions of each district's expenditure level. These can be due to idiosyncracies of individual districts or some type of misspecification of the equation. Using this procedure does not add much to explanatory power but does add to the policy relevance of the simulations. The researcher simply accepts the inability to predict this portion of revenues. By adding these in, the researcher is dealing with revenue levels closer to those that decision makers are accustomed to observing.

Another limitation of the statistical fiscal response equations is that the ability to predict expenditures for school districts is limited by the historical data analyzed. The relationship observed may only hold for the range of data on which the equations are estimated. The more the new aid formula alters the amounts and/or pattern of aid from its historical levels, the less able is the researcher to derive accurate predictions of subsequent fiscal behavior. This is true even if the structure of the aid formula does not change.

Another problem for prediction is that district taxing behavior may change if and when the fiscal structure changes. Current behavior may be a function of the status quo (Grubb and Michelson, 1974). The recent results of Carroll and Park (1979) discussed in Section II, however, are reassuring; the implementation of a dramatically different formula in Michigan did not appear to alter the fiscal behavior of these school districts.

A final word of explanation or caution is needed. The word "prediction" usually brings to mind future periods of time. The decision maker is interested in knowing, ahead of time, what the level of average expenditures, or state aid, will be. This is not the intent nor the capability of the present fiscal response/simulation model. The prediction is intended to answer a question that is hypothetical in nature: "What would have been the distribution of aid, expenditures and tax rates had the state implemented alternative aid programs to the one presently used?"

The simulation results presented in the following section describe several distributions of total expenditures that can be evaluated within the context of given policy goals. The description of these distributions are improved by the inclusion of individual district fiscal response. These predictions do not, however, describe levels of spending that will prevail in future years. The statistical equations could be used to make such predictions if necessary data were available. This would require knowledge, or prediction, of future values of all factors affecting expenditures, not just predicted state aid. If projection into the future were undertaken, inclusion of individual fiscal responses should also be used in such predictions of future spending levels.

IV. Simulation Results

The present statistical analysis of New York school districts provides a number of fiscal response equations that could be incorporated into the simulation model. Four of the sets of total and local revenue equations estimated are used, those presented in Tables A-1 through A-4. Three of these represent the conceptual models discussed. Table A-1 is the model in nominal dollars. Table A-2 is the model incorporating the cost of education index, and Table A-3 is the model with both the cost index and noneducation revenues. Results in Table A-4 are estimates of the model in nominal dollars on the pooled data set. The results of the fiscal response/simulation models are presented in Appendix B, Tables B-1 through B-9. Each table in this appendix incorporates either a specific assumption about fiscal response or the actual fiscal response equations. A complete guide to the fiscal response/simulation models is provided in the introductory section of Appendix B, Table 2.

The simulation tables present data by deciles of simulated expenditures per pupil.[21] The predicted change in the level of general state aid and expenditure, as well as other district characteristics are included. Finally, the tables show measures of equity of each predicted distribution, the cost to the state, and the resulting division between state and local financing.

The school aid program simulated in Tables B-1 to B-6 is a two-tiered percentage equalizing program that includes special pupil weights for high cost student populations, a geographic cost index and income factor.[22]

The *basic* formula for a percentage equalizing program is:

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[21] Two additional tables (B-4 and B-5) are included for the nominal dollar model of fiscal response. These present data by deciles of income per return and full value of property per pupil.

[22] See the text of Appendix B for a full description of the school finance formula simulated.

$$A_i = (1 - LS * FV_i/FV_a) E_i$$

where

A_i = aid per pupil in the i^{th} district
LS = local share of expenditures, a set percentage
FV_i = full value of property in the i^{th} district per pupil
FV_a = statewide average full value of property per pupil
E_i = expenditure per pupil in the i^{th} district

The simulations that do not use the fiscal response equations are presented in the first tables (B-1 and B-2). These simulations rely on two simple assumptions about the fiscal response of districts that have been used in the absence of estimated equations. The first simulation assumes that districts use all increases (decreases) in general aid to increase (decrease) expenditures. The second assumes that districts increase (decrease) expenditures by $0.50 for every dollar increase (decrease) in aid. These are handled by simple algebraic statements in the simulation process.

The mechanics of simulations that use the fiscal response equations are the same; the statistical equations from Appendix A are incorporated at two points.[23] The total revenue equation is used to predict changes in operating expenditures per pupil in response to the small price incentive inherent in the second tier of the formula.[24] This predicted expenditure level is then used to estimate the additional amount of aid received by districts which alter spending behavior. Finally, the local revenue equation is used to predict changes in local revenue with changes in the amount of aid received.

The basic improvement provided by the simulations that use the fiscal response equations is an individualized fiscal response for each district. Although the coefficients for the overall samples are used, individual district data on all independent factors are included in the predicting equations. The equations analyzing fiscal response are in log-form, which assumes the basic relationship among the explanatory factors is multiplicative. This simply means that the level of local revenues per pupil, for example, is not the result of adding values of the explanatory factors together,

[23] For a detailed algebraic description of how the equations are used, see the introduction of Appendix B. A list of the various models and the respective simulation tables is also provided.

[24] When a formula is structured so that there is "matching" of state to local revenues, this essentially alters the price of education revenues for school districts. This also creates an incentive for the district to alter its taxing behavior so as to receive more aid. Amounts of new aid therefore cannot be easily simulated. In the present simulations, changes in predicted expenditure levels are derived first, and then used to predict amounts of aid received under the percentage equalizing program.

but multiplying them. Thus, the levels of factors other than equalization aid itself can affect how a district will use that aid.

An example, using the local revenue equation in Table A-1 can illustrate this point:

$$\text{Local revenues per pupil} = 2.0\,(\text{Equalization aid per pupil})^{-.51}\,(\text{Residential market value per pupil})^{.66}\,(\text{Income per return})^{.31}$$

If we assume two districts have the same income, $13,270, and per pupil equalization aid, $865, this truncated[25] equation predicts that a district with $36,754 of residential property value per pupil raises $1,281 per pupil in local revenue and a district with $6,834 of residential property value raises $590.[26] If the aid received by these districts is increased by $100, the equation implies the higher wealth district will raise only $1,257 in local tax revenues, a reduction of $24, and the lower wealth district, $579 per pupil, a reduction of $11. Although these districts are hypothetical, the example does illustrate that locally financed spending, as well as the use of additional dollars of aid, are systematically related to the district's own fiscal characteristics. Indeed, this example suggests an inverse pattern of increased spending to property wealth. The low wealth district uses approximately $0.11 of each dollar for tax relief and spends $0.89, while the higher wealth district uses $0.24 for tax relief, spending $0.76 of each dollar.

With all independent factors included in the equation and actual amounts of simulated aid introduced, the patterns of response predicted by each fiscal response model are shown in the simulation tables B-3 through B-9.

A consistent finding for simulations using the individualized district response, regardless of the various methods of estimating response,[27] is a nonlinear spending pattern. Districts in the lowest

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[25] This equation uses only the constant term and three independent variable coefficients. For purposes of exposition, the value of the other variables is assumed equal for the two districts.

[26] The reader should note that these property values are for residential property only. The equations are estimated with only this measure of property wealth in dollar terms. Nonresidential property exerts a "price" effect that is reflected in the equations in the tax base composition variable (percentage residential property of total property value).

[27] The level and pattern of spending *are* slightly different for the simulation using estimates of response from Table A-2, which is an analysis of real dollars of revenue.

expenditure decile tend to use more additional dollars of nominal aid to increase real expenditures than those in the highest decile of expenditures. This pattern of spending is seen by comparing two columns of output in the tables (B-3, B-6 through B-9): the change in real expenditures from their 1979/80 level and the corresponding change in actual or nominal state aid.[28] For example, the average increase in real expenditures for districts in the lowest decile of expenditures in Table B-3 is $108 with an average increase in aid of $117. This implies $0.92 of each dollar of aid is used to increase real education expenditures per pupil. This propensity to spend decreases to approximately $0.50 of each dollar for districts in the middle decile and equals $0.75 for districts in the highest expenditure decile. This pattern is consistent for each simulation. The results in Table B-5, which use response estimates from a pooled data set (Table A-4), actually indicate a dollar for dollar increase in real expenditures with increases in aid in the lowest spending decile. Districts in the highest decile of expenditures spend approximately $0.80 of each dollar of aid.

When district response to general aid is viewed in relation to New York gross income per return, a similar pattern emerges. The deciles in Table B-4 rank districts in terms of income per return.[29] The average spending response for districts in the lowest income decile is approximately $0.80 of each dollar of general aid. This response declines to $0.56 for those districts in the eighth decile. Beyond this point, however, districts tend to lose aid relative to that received in 1979/80 due to an income adjustment on the measure of local school district wealth.[30]

The pattern of spending response to aid can also be viewed by deciles of full property value per pupil. This is shown in Table B-5, which uses the nominal dollar fiscal response estimates (Table A-1) in the simulation process. The results indicate a decline in response in district spending from low to high wealth deciles. Districts in the lowest decile, on average, spend $0.80 of each additional dollar of aid; those in the seventh decile spend approximately

[28]Simulated expenditures are deflated by a geographic cost-of-education index when aid is distributed on the basis of the cost index. This results in a better description of the distribution of real resources available to school districts.

[29]This simulation uses the fiscal response equations estimated in nominal dollar terms (Table A-1). The remaining fiscal response/simulation models exhibit a similar pattern across income deciles and are not presented here.

[30]See Appendix B for the full algebraic description of the formula that is simulated.

$0.60 and those in the eighth, only $0.30 of additional dollars of aid.

The response to aid for the New York City school district as well as the statewide measures are fairly stable for the simulations in Tables B-3 through B-9. The estimate of additional real dollars of spending for New York City is between $0.37 and $0.52 of each new dollar of aid. The statewide average response varies from $0.59 to $0.76 in the alternative simulation models. This lower response of real spending for the city is a combination of slightly less use of aid and relatively higher costs for that school district.

The fiscal response/simulation models are extremely comparable in terms of the predicted patterns of fiscal response. These models also provide various estimates of the impact of the simulated program on school finance equity. The statistics in Table 1 provide a basis for comparison on a variety of school finance goals. The consistency of these measures[31] for the simulations using the simple assumptions as well as those using the actual equations is considered.

The results are both surprising and pleasing. The equity measures are very stable when compared across simulations using the actual fiscal response equations. For example, the coefficient of variation[32] has a value of .16 or .17 for all fiscal response/simulation models. This says the dispersion of the predicted expenditure distribution is not sensitive to the underlying statistical equations that are used to predict. The statistics that measure the degree of wealth relatedness of expenditures[33] in the system also produce consistent results for the set of simulations. The wealth elasticities range from .12 to .13. The elasticity of expenditures with respect to income only varies between .35 and .38.

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[31] The four measures used in Table 1 to reflect equity are the wealth and income elasticities of expenditure, the range of expenditures and the coefficient of variation. These are defined in detail in the glossary in Appendix C.

[32] This is a statistical measure of the variation in expenditures about the mean.

[33] Wealth neutrality is one standard of equity for a school finance system. It states that expenditures per pupil cannot be positively related to a measure of local district ability to pay, such as property wealth or household income. One way of measuring how strong expenditures are related is to estimate an elasticity. The elasticity reflects the relationship in percentage terms, a one percent difference in local property wealth is associated with a given percent change in expenditures per pupil. This relationship between expenditures and income can also be measured.

Table 1
Equity Measures

Simulation Model	Wealth Elasticity	Income Elasticity	Expenditure Range 90th–10th Percentile	Coefficient of Variation	Cost to State (Millions)
Simple Assumptions					
No fiscal response	.15	.30	$659	.15	$816
50-50 fiscal response	.19	.43	586	.13	816
Conceptual Issues					
Fiscal response from analysis of nominal dollars	.12	.35	690	.17	1,125
Fiscal response from analysis of real dollars	.12	.38	674	.17	1,108
Fiscal response from analysis with municipal overburden	.12	.36	683	.17	1,117
Statistical Issues					
Fiscal response from analysis of pooled data	.13	.35	679	.16	1,025
Fiscal response using Wisconsin price estimate*	.13	.37	652	.16	1,022

*This simulation uses the cross-sectional results from the one-year nominal dollar analysis (Table A-1) with the estimate for the price response from the Wisconsin analysis (Table A-7).

A surprising result is that these simulations are fairly comparable to those using the simple fiscal response assumptions.[34] A more detailed comparison of these simulations illustrates how individualized response measures improve the analysis.

The simulation that assumes districts use all aid increases (decreases) to increase (decrease) expenditures indicates the final expenditure distribution will have a wealth elasticity equal to .15 and an income elasticity of .30. By comparison, all simulations that use the actual fiscal response equations estimate *lower* wealth relatedness of expenditures, elasticities equal .12 to .13, and *higher* elasticities with respect to income, .35 to .38.

The lower wealth elasticities are due to the particular pattern of predicted fiscal response to aid discussed earlier. Lower wealth districts tend to use more of additional dollars of general aid to increase expenditures. They receive relatively more aid under the

[34] Recall the simple assumptions are that districts (1) spend all additional aid or (2) spend half and use the other half for tax relief.

simulated program and use relatively more of it in increased spending. By assuming that all districts behave the same, this simple fiscal response assumption understates the impact on this particular equity goal. The simple assumption, however, *overstates* the impact on the income-related goal. This is because all decreases in aid for the high income districts are assumed to translate into expenditure decreases. In reality, these districts are likely to raise local tax revenues to partially offset these losses. The individual fiscal response/simulation models account for and quantify this response.

The simulation that assumes districts uniformly spend half of the new aid received tends to understate the impact on both the wealth and income neutrality goals. In a sense, it doesn't give full credit to the impact of aid. By assuming that low-wealth and high-wealth districts both tend to spend $0.50 of additional aid, when they appear to actually spend $0.80 and $0.30 respectively, does not capture the true impact of new aid on equity.

A major difference between any of the simulations that use fiscal response equations and the present simulations using simple assumptions is a substantive difference in the predicted cost to the state. That is, the amount of additional aid the state would need to fund the particular program increases from approximately $800 million with the simple fiscal assumptions to as much as $1,125 million. The primary reason is that the simple assumptions do not allow for an interaction between expenditure decisions and the receipt of aid. When the model doesn't allow for this interaction, it necessarily underestimates the costs of a power equalizing program. The fiscal response simulation includes an iterative process to account for the interaction of spending behavior and the receipt of aid inherent in such programs.

As discussed earlier, the price incentive inherent in the second tier of the formula simulated may induce districts to increase their local effort, which increases their aid. This greater amount of total aid may partially account for the lower wealth elasticities in the present simulations. This does not necessarily follow, however. If only high wealth districts responded to such price incentives, this interaction could lead to more total aid but less equity. The predicted pattern of response to the price incentive across wealth deciles, as well as spending of that additional aid, is such that the impact on equity is comparable.

In summary, the simulation results indicate that the use of several statistical and conceptual approaches to fiscal response do not impact the predicted equity of the particular school aid formula

simulated. When the four measures of expenditure equality or wealth neutrality are compared among simulations, the results are extremely stable. Measures of equity for the fiscal response simulations compared to simulations using simple assumptions are also close. The comparability of results is *not* because the use of the fiscal response equations does not alter the results. Rather, it is because the use of actual fiscal response equations reveals a *pattern* of new spending for low wealth, low expenditure districts that works with the distribution of new aid to actually improve the predicted wealth neutrality of the system. Slight, but important differences are seen, therefore, in the equity statistics. In particular, the simple assumption of one-half expenditure increase tends to understate the impact of new aid on the equity goals. The *cost* of the aid program is *significantly* higher in the fiscal response simulations since it accounts for the interaction of district spending and aid received.

V. Conclusions, Policy and Future Research

The conclusions of this study include those regarding the statistical and conceptual issues that arise when analyzing school district fiscal response. It also looks at the simulation process itself. The former have policy implications for the basic *structure* and *parameters* of school aid formulas; the latter is useful when *evaluating* alternative formulas.

The primary conclusion from analyzing the statistical issues is that school districts do appear to spend more additional aid when that response is measured over more than one time period. Whether this involves analyzing variables in "change" form or pooling several years of cross-sectional data, the measures indicate greater increases in education expenditures with increases in state aid.

The interesting finding is that the results of a one-year cross-sectional analysis, when incorporated in the simulation, *also* indicate this greater increase in expenditures. The estimates of the average addition to expenditures with additional aid is approximately $0.55 in the set of simulations; the estimate of this response from the "change" analysis is $0.60. It appears that cross-sectional analysis using the particular individual data set in the prediction and simulation process performs well in reflecting this basically dynamic process.

The measure of response to aid when analyzed along varying conceptual lines differs slightly in the statistical equations. If the focus is only on this one response, analysis of nominal dollars of revenue with some effort to "account" for cost factors[35] appears adequate. Analysis of real dollars of revenue, however, has import beyond measuring response to aid. First, this type of analysis provides an explanation of variations in real resources per pupil and second, it measures the impact of differences in resource prices on the amounts purchased. School district response to this factor as well as property wealth and income factors can have implications for the basic structure of the school aid formula. The

[35] When fiscal response is measured in nominal terms only, researchers include factors that affect the costs of producing services, such as the size of the district and general price level in the school district.

use of an index to reflect geographic variations in the prices of education inputs would be recommended given the results in Table A-2. Similarly, the recommendation of an income factor to adjust the measure of school district wealth, as well as its weighting, can be derived from these results. Finally, the cost index itself is needed in evaluating the simulation results once aid is distributed in relation to these price variations. The expenditure disparities described by the present simulations are in terms of real dollars of revenue, or real resources per pupil.

A major purpose of this study was to gauge the equity measures of the simulations under these varying statistical and conceptual approaches. The overwhelming conclusion from these simulations is that the equity measures are extremely stable despite varying estimates of school district fiscal response. Policy statements concerning the efficacy of the particular program simulated would not be altered by the approach used to measure fiscal response. This conclusion is drawn from the simulation of a program that benefits from a well-developed cost index and has been previously modified by several factors to maximize the equity achieved. Here, too, the approach used to measure fiscal response depends on the breadth of issues before decision makers. Although analysis of nominal dollars of revenue provides a good estimate of fiscal response statistically and in the simulation process, this analysis does not shed light on variations in costs, their effect on spending, or help evaluate real expenditure disparities.

It *is* important to include some form of individualized fiscal response estimates in the simulation process for several reasons. This provides the best description of the tax and expenditure pattern among school districts. The equity measures in the fiscal response simulations are importantly different from those using the simple assumptions. With the individualized response, the total level of aid and specific pattern of spending is different. If decision makers are concerned with results for particular districts or groups of districts, the individualized response is informative. Finally, the predicted cost to the state is significantly affected by the inclusion of individual fiscal response. This could have greater impact if the program being simulated had a stronger or more pervasive "price" effect. In particular, if this matching incentive covered a wider range of expenditures than the program presently being simulated, the equity measures would likely be affected.

This study shows how the use of equations estimating individualized fiscal response can significantly improve the ability of simulations to describe the expected distribution of school district expenditures under a restructured school aid program. These

distributions are described using various measures of equity for policy evaluation. Yet, an inherent limitation remains. These distributions are hypothetical in the sense that they describe the distribution that would have prevailed under the alternative program in the school year analyzed.

Policy makers are inevitably considering and evaluating programs today that will be implemented over the coming years. The question that remains is how well the present fiscal response simulations describe those future expenditure distributions? The critical question is how the underlying factors that create disparities (property wealth, income and so forth) grow over time. The only factor in the decision makers' control is the amount of state aid; the simulation process describes the amount "needed" to achieve certain equity goals. The conclusion regarding the impact on equity may yet be misleading if school district property wealth, income and/or other factors change so as to counteract the expected impact. The remaining task for school finance simulations is to develop the ability to predict future levels of all critical factors, not just state aid, and simulate expected distributions of expenditures in future school years.

Appendix A
Statistical Equations and Data Sources for Wisconsin and New York School Districts

The equations presented in this appendix, A-1 through A-10, reflect the empirical results from analyzing the statistical and conceptual issues discussed in Section II of the text. They are a combination of cross-section, pooled cross-sectional and first difference analysis. Each table includes a total and local revenue equation. As such, they show the set of factors that impact total and locally financed education revenues per pupil.

In Tables A-1 through A-4, and A-7 through A-9, the variables are in natural logarithm form so that the coefficients represent elasticities, as defined in Appendix C, Glossary of Terms. When the variables are in "change" form as in Tables A-5, A-6 and A-10, the coefficients measure the change in the dependent variable associated with a one unit change in the independent variable. The t-statistics in parentheses beneath the estimated coefficients show whether the hypothesized relationship can be counted on with a certain degree of confidence (see table footnotes). The value of the "R^2" at the bottom of the tables indicates the percentage of total variation in the independent variable (revenues per pupil) that is explained by the combination of factors included in the equation.

The title of each table describes the data set used in the analysis. For example, Table A-4 uses nominal dollar values and two years of pooled data for the New York school districts. The tables provide comparisons among the varying models and statistical analyses that have been discussed. As shown in the tables, slight differences emerge in the measures of district response to aid when the statistical procedures differ. A more powerful test of the differences in this measure of response, however, occurs with the incorporation of these equations into the simulation model. In that process, the equations are used to predict changes in total and local revenues with changes in aid. The ability of cross-sectional analyses to make inferences about dynamic behavior can be gauged as well as the stability of these inferences from the one year of analysis versus the pooled data sets.

Data Sources

The set of data used in the statistical analysis of New York school districts was derived from tapes provided by various New York State agencies. The primary set of data, including state and federal aid, pupil counts, local tax revenues, full value and income per return, was provided by the Bureau of Educational Finance Research of the state department of education. Additional data from the Department of Audit and Control and the Division of Equalization and Assessment enabled the author to estimate current market values of residential property. Finally, the data on levels of noneducation revenues were provided by Jerry Miner and Seymour Sacks of Syracuse University, who had allocated data provided by the New York State agencies to school districts. Other data items such as median years of schooling were derived from the fourth count census tape for New York school districts.

For Wisconsin school districts, the major set of data was obtained from hard copy publications of the Wisconsin Department of Public Instruction. These items include state and federal revenues, membership counts and nonpublic enrollment counts. Data on local revenues, assessed valuations by property class, sales ratio data and Wisconsin gross income were obtained from the Wisconsin Department of Revenue, Division of State and Local Finance.

Table A-1
Fiscal Response Coefficients* for Nominal Data on Total and Locally Financed Expenditures per Pupil in New York School Districts in 1976-77**

Variable	Total	Local
Constant Term	3.055	1.975
Equalization Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.073 (2.353)	−0.513 (8.441)
State Categorical Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.113 (13.730)	0.099 (6.068)
Federal Revenue per Pupil (Adjusted $/Combined Adjusted ADM)	0.002 (1.383)	−0.003 (1.042)
Residential Market Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.270 (16.159)	0.664 (20.213)
Percent Residential Value per Pupil (Adjusted $/Combined Adjusted ADM)	−0.322 (12.634)	−0.675 (13.472)
New York Gross Income per Return (Adjusted $/Return)	0.352 (12.359)	0.311 (5.546)
Pupils	−0.230 (6.070)	−0.175 (2.351)
Pupils Squared	0.013 (5.398)	0.012 (2.657)
Density of Student Population (Pupils /Square Mile)	0.030 (6.923)	0.068 (7.979)
Pupil Growth Rate	−0.097 (5.690)	−0.114 (3.395)
Percent Minority Pupils	0.011 (4.245)	0.013 (2.447)
Ratio of Nonpublic to Public Enrollment	0.000 (0.025)	0.017 (1.617)
Median Years of Schooling	−0.076 (0.767)	0.500 (2.554)
R^2	0.91	0.90
S.E.E.	0.1112	0.2188

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficient. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-2
Fiscal Response Coefficients* for Real (Cost-Adjusted) Data on Total and Locally Financed Expenditures per Pupil in New York School Districts in 1976-77**

Variable	Total	Local
Constant Term	3.012	5.243
Equalization Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.038 (1.875)	−0.765 (19.485)
State Categorical Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.094 (11.556)	0.065 (4.080)
Federal Revenue per Pupil (Adjusted $/Combined Adjusted ADM)	0.013 (3.465)	0.009 (1.239)
Residential Market Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.289 (23.019)	0.553 (22.557)
New York Gross Income per Return (Adjusted $/Return)	0.234 (7.495)	0.130 (2.143)
Pupils per Capita	0.263 (7.395)	0.434 (6.247)
Generalized Tax Price (Percentage Residential times Relative Price Index times Pupils per Capita)	−0.321 (17.256)	−0.502 (13.850)
Pupil Growth Rate	−0.124 (7.518)	−0.204 (6.341)
Ratio of Nonpublic to Public Enrollment	0.001 (0.555)	0.011 (2.524)
Median Years of Schooling	0.096 (0.934)	0.775 (3.881)
R^2	0.72	0.87
S.E.E.	0.1128	0.2199

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-3

Fiscal Response Coefficients* for Real (Cost-Adjusted) Data on Total and Locally Financed Expenditures per Pupil Including Municipal Expenditures in New York School Districts in 1976-77**

Variable	Total	Local
Constant Term	2.142	1.894
Municipal Revenues (Predicted Essential $/Capita)	0.203 (10.784)	0.410 (11.040)
City Municipal Revenues (Interaction Dummy; 1 – if District is Coterminous with Major City; 0 – otherwise)	–0.004 (1.377)	–0.011 (1.915)
Equalization Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.054 (2.185)	–0.546 (11.266)
State Categorical Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.108 (14.338)	0.086 (5.800)
Federal Revenue per Pupil (Adjusted $/Combined Adjusted ADM)	0.013 (3.909)	0.010 (1.475)
Residential Market Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.224 (14.508)	0.553 (18.189)
Percent Residential Value per Pupil Adjusted $/Combined Adjusted ADM)	–0.269 (12.279)	–0.577 (13.349)
New York Gross Income per Return (Adjusted $/Return)	0.237 (8.230)	0.095 (1.674)
Relative Price Index (Cost of Education Index/ General Cost of Living Index)	–1.368 (9.979)	–0.950 (3.515)
Pupils per Capita	–0.019 (0.704)	–0.012 (11.266)
Pupil Growth Rate	–0.093 (5.970)	–0.122 (3.975)
Ratio of Nonpublic to Public Enrollment	–0.004 (1.588)	–0.002 (0.373)
Median Years of Schooling	0.018 (0.196)	0.695 (3.754)
R^2	0.76	0.89
S.E.E.	0.1026	0.2023

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-4
Fiscal Response Coefficients* for Nominal, Pooled Data on Total and Locally Financed Expenditures per Pupil in New York School Districts, 1975-76 and 1976-77**

Variable	Total	Local
Constant Term	0.147	−3.694
Equalization Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.086 (4.020)	−0.364 (8.171)
State Categorical Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.191 (26.784)	0.158 (10.613)
Federal Revenue per Pupil (Adjusted $/Combined Adjusted ADM)	0.020 (6.390)	0.003 (0.490)
Residential Market Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.054 (4.033)	0.102 (3.656)
Percent Residential Value per Pupil (Adjusted $/Combined Adjusted ADM)	−0.110 (6.305)	−0.126 (3.449)
New York Gross Income per Return (Adjusted $/Return)	0.364 (19.855)	0.328 (8.563)
Pupils	−0.047 (8.811)	0.001 (0.105)
Pupils Squared	0.010 (6.373)	0.009 (2.980)
Density of Student Population (Pupils /Square Mile)	−0.190 (11.902)	−0.554 (16.589)
Pupil Growth Rate	−0.068 (3.631)	−0.038 (0.967)
Percent Minority Pupils	0.014 (5.523)	0.027 (5.256)
Ratio of Nonpublic to Public Enrollment	−0.004 (1.426)	0.003 (0.5[illegible])
Median Years of Schooling	0.008 (0.122)	0.466 (5.090)
Cost of Living Indicator (Full Value per Square Mile)	0.216 (13.761)	0.608 (18.549)
R^2	0.82	0.90
S.E.E.	0.1010	0.2109

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-5
Fiscal Response Coefficients* for Changes in Nominal Data on Total and Locally Financed Expenditures per Pupil in New York School Districts, 1975-76 to 1976-77**

Variable	Total	Local
Constant Term	−193.067	−209.108
Equalization Aid per Pupil (Adjusted $/Combined Adjusted ADM)	0.592 (3.618)	0.040 (0.249)
State Categorical Aid per Pupil (Adjusted $/Combined Adjusted ADM)	1.057 (33.367)	0.067 (2.136)
Federal Revenue per Pupil (Adjusted $/Combined Adjusted ADM)	0.968 (5.651)	−0.022 (0.130)
Residential Market Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.008 (16.615)	0.008 (16.720)
Percent Residential Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.369 (1.222)	0.331 (1.105)
New York Gross Income per Return (Adjusted $/Return)	0.025 (4.258)	0.025 (4.259)
Pupils	−4.001 (0.164)	6.428 (0.265)
Pupils Squared	0.003 (0.274)	−0.002 (0.164)
Density of Student Population (Pupils /Square Mile)	−0.834 (4.958)	−0.765 (4.597)
Pupil Growth Rate	−2.234 (1.948)	−1.265 (1.114)
Ratio of Nonpublic to Public Enrollment	−1.953 (3.549)	−1.973 (3.620)
Median Years of Schooling	18.121 (2.971)	18.998 (3.145)
R^2	0.74	0.42
S.E.E.	92.336	91.426

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-6
Fiscal Response Coefficients* for Changes in Nominal Data on Total and Locally Financed Expenditures per Pupil in New York School Districts, 1975-76 to 1976-77**

Variable	Total	Local	Downstate Coefficient*** Total	Downstate Coefficient*** Local
Constant Term	−116.410	−126.823		
Equalization Aid per Pupil (Adjusted $/Combined Adjusted AD)	0.675 (4.338)	0.080 (0.526)	0.053 (2.033)	−0.346 (1.415)
State Categorical Aid per Pupil (Adjusted $/Combined Adjusted ADM)	1.036 (36.379)	0.046 (1.632)		
Federal Revenue per Pupil (Adjusted $/Combined Adjusted ADM)	1.026 (6.696)	0.036 (0.237)		
Residential Market Value per Pupil (Adjusted $/Combined Adjusted ADM)	0.002 (2.869)	0.002 (2.627)	0.010 (5.703)	0.010 (5.843)
Percent Residential Value per Pupil (Adjusted $/Combined Adjusted ADM)	−0.082 (0.300)	−0.127 (0.473)		
New York Gross Income per Return (Adjusted $/Return)	−0.025 (3.721)	−0.025 (3.281)	0.025 (7.504)	0.025 (7.503)
Pupils	−17.635 (0.805)	−9.662 (0.448)		
Pupils Squared	0.010 (0.967)	0.006 (0.589)		
Density of Student Population (Pupils /Square Mile)	−0.504 (2.823)	−0.375 (2.139)		
Pupil Growth Rate	−2.763 (2.650)	−1.867 (1.839)		
Ratio of Nonpublic to Public Enrollment	−1.293 (2.602)	−1.321 (2.705)		
Median Years of Schooling	18.461 (3.356)	18.974 (3.510)		
R^2	0.75	0.37		
S.E.E.	82.446	81.034		

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

***Coefficient relative to districts located downstate. The t-statistics, again, indicate whether these coefficients are significantly different than for districts upstate.

Table A-7
Fiscal Response Coefficients* for Data on Total and Locally Financed Expenditures per Pupil in Wisconsin School Districts, 1975-76**

Variable	Total	Local
Constant Term	3.888	−1.481
Formula Price Variable	−0.214 (5.764)	0.309 (5.508)
State Categorical Aid ($/Pupil)	0.085 (6.629)	0.079 (4.071)
Federal Aid ($/Pupil)	0.006 (1.029)	−0.018 (1.912)
Transition Aid ($/Pupil)	0.005 (1.826)	−0.007 (1.940)
Residential Market Value ($/Pupil)	0.213 (7.777)	0.532 (12.861)
Percent Residential Value	−0.191 5.774)	−0.508 (10.161)
Income Measure ($/Return)	0.182 (3.651)	0.360 (4.765)
Pupils	−0.274 (5.601)	−0.374 (5.057)
Pupils Squared	0.015 (4.705)	0.020 (4.130)
Price of Agricultural Land ($/Acre)	0.039 (2.393)	0.064 (2.588)
Pupil Growth Rate	−0.008 (2.303)	−0.014 (2.586)
Ratio of Nonpublic to Public Enrollment	−0.005 (1.96*)	−0.004 (1.005)
Type of District (Dummy Variable: 1 – K-8 District; 0 – otherwise)	−0.220 (7.742)	−0.346 (8.030)
Type of District (Dummy Variable: 1 – UHS District; 0 – otherwise)	−0.021 (0.187)	−0.262 (1.516)
R^2	0.39	0.79
S.E.E.	0.1095	0.1658
N	417	417

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-8
Fiscal Response Coefficients* for Pooled Data on Total and Locally Financed Expenditures per Pupil in Wisconsin School Districts, 1973-74 and 1975-76**

Variable	Total	Local
Constant Term	3.589	−1.843
Year of Data (Dummy Variable: 1 – if data is 1975-76; 0 – otherwise)	0.120 (11.011)	0.015 (0.949)
Formula Price Variable	−0.210 (9.458)	0.306 (9.320)
State Categorical Aid ($/Pupil)	0.076 (8.382)	0.035 (3.368)
Federal Aid ($/Pupil)	0.014 (3.039)	−0.004 (0.547)
Transition Aid ($/Pupil)	0.006 (3.707)	0.002 (0.784)
Residential Market Value ($/Pupil)	0.217 (12.038)	0.548 (20.532)
Percent Residential Value	−0.191 (9.099)	−0.520 (16.494)
Income Measure ($/Return)	0.173 (4.865)	0.346 (6.561)
Pupils	−0.229 (6.438)	−0.264 (5.009)
Pupils Squared	0.013 (5.314)	0.014 (4.008)
Price of Agricultural Land ($/Acre)	0.050 (4.249)	0.065 (3.758)
Pupil Growth Rate	−0.007 (2.711)	−0.009 (2.437)
Ratio of Nonpublic to Public Enrollment	−0.004 (2.229)	−0.004 (1.345)
Type of District (Dummy Variable: 1 – K-8 District; 0 – otherwise)	−0.243 (11.848)	−0.332 (10.926)
Type of District (Dummy Variable: 1 – UHS District; 0 – otherwise)	−0.054 (0.647)	−0.353 (2.881)
R^2	0.61	0.82
S.E.E.	0.1128	0.1670
N	834	834

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-9
Fiscal Response Coefficients* for Data on Total and Locally Financed Expenditures per Pupil, Pooled Data for Group 1** in Wisconsin School Districts

Variable	Total	Local
Constant Term	4.578	2.264
Formula Price Variable (1973-74)	−0.030 (0.918)	0.770 (15.492)
Formula Price (1975-76)	−0.210 (11.123)	0.670 (4.265)
State Categorical Aid ($/Pupil)	0.050 (5.194)	0.030 (2.208)
Federal Aid ($/Pupil)	0.016 (2.956)	0.003 (0.410)
Transition Aid ($/Pupil)	0.003 (1.342)	−0.009 (3.254)
Residential Market Value ($/Pupil)	0.169 (5.894)	0.230 (5.909)
Percent Residential Value	−0.169 (5.597)	−0.221 (5.383)
Income Measure ($/Return)	0.103 (2.215)	0.283 (4.478)
Pupils	−0.127 (2.567)	−0.113 (1.684)
Pupils Squared	0.069 (2.068)	0.005 (1.092)
Price of Agricultural Land ($/Acre)	0.007 (0.483)	0.005 (2.232)
Pupil Growth Rate	−0.005 (1.797)	−0.006 (1.586)
Ratio of Nonpublic to Public Enrollment	−0.003 (1.684)	−0.217 (6.955)
Type of District (Dummy Variable: 1 – K-8 District; 0 – otherwise)	−0.155 (6.740)	−0.091 (0.665)
Type of District (Dummy Variable: 1 – UHS District; 0 – otherwise)	0.188 (0.188)	0.189 (0.184)
R^2	0.55	0.83
S.E.E.	0.0970	0.1320

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Table A-10
Fiscal Response Coefficients* for Changes in Total and Locally Financed Expenditures per Pupil in Wisconsin School Districts, 1973-74 to 1975-76**

Variable	Total	Local
Constant Term	239.421	168.048
Formula Price Variable	−31.877 (1.191)	64.727 (2.266)
State Categorical Aid ($/Pupil)	1.274 (4.931)	0.236 (0.856)
Federal Aid ($/Pupil)	1.206 (7.356)	−0.170 (1.040)
Transition Aid ($/Pupil)	0.783 (4.608)	−0.342 (1.886)
Residential Market Value ($/Pupil)	−0.000 (0.170)	0.002 (0.856)
Percent Residential Value	−0.212 (0.002)	−4.165 (3.794)
Income Measure ($/Return)	−0.001 (0.032)	−0.026 (1.196)
Pupils	−35.362 (0.880)	−61.404 (1.432)
Pupils Squared	0.152 (0.844)	0.263 (1.365)
Price of Agricultural Land ($/Acre)	0.040 (2.369)	0.055 (3.111)
Ratio of Nonpublic to Public Enrollment	0.835 (1.764)	0.096 (0.045)
Type of District (Dummy Variable: 1 – K-8 District; 0 – otherwise)	67.980 (3.169)	37.204 (1.625)
Type of District (Dummy Variable: 1 – UHS District; 0 – otherwise)	143.357 (1.224)	69.709 (0.558)
R^2	0.27	0.22
S.E.E.	114.187	121.879

*All variables are in log-form. The coefficients are measures of elasticities (the percent effect on the dependent variable in response to a 1 percent change in the independent variable).

**T-statistics are in parentheses below the regression coefficients. Variables are statistically significant using a two-tailed test at the 90 percent level of confidence when the t-statistics are greater than 1.65 and at the 95 percent level when greater than 1.96.

Appendix B
Mechanics and Results of the Simulation Models

This appendix includes the summary printouts for all simulations using an individualized fiscal response. Each table represents a different statistical or conceptual model of fiscal response. A reference guide to these tables is provided in Table 2. Also included in this appendix is an algebraic description of the formula being simulated and the use of the fiscal response equations in the simulation model.

Although the basic structure of the formula simulated for New York school districts is a percentage equalizing program, it includes several modifications. These modifications are recommendations from a series of statistical analyses; each modification moves the system toward specific school finance goals. The formula can be described algebraically in two equations as follows:

$$A_{1_i} = \left(1 - \frac{FV_i}{FV_k} * \frac{INC_i}{INC_k} * .51\right) * \$1{,}516 * TCOSTX_i$$

$$A_{2_i} = \left(1 - \frac{FV_i}{FV_k} * \frac{INC_i}{INC_k} * .80\right) * (\$2{,}322 - \$1{,}516) * TCOSTX_i$$

$$A_i = A_{1_i} + A_{2_i}$$

where

A_{1_i} = aid per pupil in the i^{th} school district under the first tier

A_{2_i} = aid per pupil in the i^{th} school district under the second tier

$A_i = A_{1_i} + A_{2_i}$

A_i = aid per pupil in the i^{th} school district

FV_i = full property value per pupil in the i^{th} district

INC_i = New York gross income per return in the i^{th} district

FV_k = key full property value per pupil (61st percentile)

INC_k = key New York gross income per return (75th percentile)

$TCOSTX_i$ = cost-of-education inputs index in the i^{th} district

In addition, the following pupil weightings are included to account for special pupil needs:

Secondary pupils	= 1.25
Elementary PSEN pupils	= 1.35
Secondary PSEN pupils	= 1.35
Bilingual pupils	= 1.40
Handicapped pupils	= 2.00

Finally, the pupil count in order to consider the problems of declining enrollment is the greater of the actual count or the average of the past three years.

The aid from the first tier of this formula (A_1) is provided for an expenditure level of $1,516, regardless of the district's actual expenditures. Aid from the second tier (A_2) is affected by the district's actual spending behavior, if they spend beyond $1,516 but less than $2,322 per pupil. Over this range of expenditures, the formula provides a matching incentive, and therefore, a "price" effect.

The matching rate for the i^{th} district in a general form is defined as follows:

$$m_i = \frac{A_i}{E_i}$$

where

A_i = aid per pupil in the i^{th} district

E_i = expenditures per pupil in the i^{th} district

and the price of additional dollars is:

$$P_i = 1 - m_i$$

From the particular formula simulated for New York school districts, and expressing expenditures between $1,516 and $2,232 as E_i, these two expressions become:

$$m_i = \frac{\left(1 - \frac{FV_i}{FV_k} * \frac{INC_i}{INC_k} * .80\right) * TCOSTX_i * E_i}{E_i}$$

$$= \left(1 - \frac{FV_i}{FV_k} * \frac{INC_i}{INC_k} * .80\right) * TCOSTX_i$$

and

$$P_i = 1 - \left[\left(1 - \frac{FV_i}{FV_k} * \frac{INC_i}{INC_k} * .80\right) * TCOSTX_i\right]$$

which is simply one minus the aid ratio of the percentage equalizing formula, adjusting by the cost index. Intuitively, this simply says that when the price of additional dollars of revenue is higher, the aid ratio is lower. If a district has relatively low full value and/or income per return, the aid ratio is higher, and the price inherent in the formula is lower. Further, this aid ratio is adjusted by the cost of education inputs. If the price of inputs are high, the aid ratio is adjusted upward, which means the price of education revenues to the district is somewhat lower.

The price variable is used in the total revenue equations derived from Tables A-1 through A-4 to predict changes in expenditures.

Two total revenue equations and their use in the simulations can be expressed algebraically:

$$TREV_i = Z_i + U_i - .32\,(PRICE)$$

$$TREV'_i = Z_i + U_i - .32\,(PRICE)'$$

where

$TREV_i$ = predicted total revenues per pupil in i^{th} district under old aid structure

$TREV'_i$ = predicted total revenues per pupil in i^{th} district under new aid structure

Z_i = vector of independent variables for i^{th} school district weighted by regression coefficients

U_i = estimated residual for i^{th} school district

PRICE = price of revenues under old aid structure, equal to 1.00 for all districts

PRICE′ = price of revenues under new aid structure, equal to P_i from above

Intuitively, this process uses the estimated equations to first predict the total per pupil revenues/expenditures for each district, given its individual characteristics and the amount of aid received under the old program. Since the old aid program did not have a matching provision ($m_i = 0$), the price of revenues included in the equation was set equal to one for all districts. The equation used to predict total revenue/expenditures for each district under the new formula includes the amount of aid received under the first tier of the formula and the price of revenues inherent in the second tier. In both of these equations, the value of the coefficient on the price variable is assumed to equal − .32, even though there is not an existing price incentive on which to estimate this coefficient.* This is based on the argument of several authors (Ladd, 1975; Black, Lewis and Link, 1979) that the price effect from the composition of the tax base is equivalent to the price effect from a school aid formula.** The estimated coefficient for the tax base composition of New York school districts is − .32 in the first set of equations (Table A-1). The difference in these two predicted values is then used to adjust approved operating expenditures of school districts as shown below:

$$CTREV_i = TREV'_i - TREV_i$$

$$E'_i = AOEP_i + CTREV_i$$

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*An estimate of this price response was also derived from the Wisconsin results, Table A-7, which equals −.21. The impact of this lower response to price is seen in the simulation in Table B-9. The primary effect is a lower cost to the state in terms of additional dollars of aid.

**The Wisconsin price estimate was also used in an attempt to simulate a Guaranteed Tax Base program for New York school districts. This required using the local revenue equations to predict changes in the tax rate as the "price" of school revenue is altered under such a program. The local revenue equations did not perform in predicting these changes; predicted levels were so large as to be implausible. This could be due to the use of an extraneous price estimate and/or its inclusion in a statistical equation fit on data for school districts having no historical experience with such a price variable.

where

$CTREV_i$ = predicted change in total revenue per pupil in the i^{th} district

E'_i = predicted expenditures per pupil in i^{th} district under new formula

$AOEP_i$ = approved operating expenditures per pupil in i^{th} district

This predicted expenditure per pupil (E'_i) is then used to simulate aid under the second tier of the formula:

$$A_{2_i} = \left(1 - \frac{FV_i}{FV_k} * \frac{INC_i}{INC_k} * .80\right) * E'_i$$

Aid under the first and second tier is then combined and used in the local revenue equations:

$$A'_i = A_{1_i} + A_{2_i}$$

$$LREV_i = L_i + U_i - .XX(A_i)$$

$$LREV'_i = L_i + U_i - .XX(A_i)'$$

where

$LREV_i$ = predicted local revenue per pupil in i^{th} district under old aid program

$LREV'_i$ = predicted local revenue per pupil in i^{th} district under new aid program

L_i = vector of independent variables for i^{th} school district weighted by regression coefficient

U_i = estimated residual for i^{th} school district

$.XX$ = coefficient on equalization aid from appropriate equation

A_i = aid under old aid program

A'_i = aid under new aid program, as calculated above

The change in these predicted levels of local revenue is then used to adjust the data on approved operating expenditures per pupil in the i^{th} school district

$$CLREV_i = LREV'_i - LREV_i$$

$$AAOEP = AOEP + CLREV_i$$

The change in aid received by the school district is:

$$CAID = A'_i - A_i$$

and simulated expenditures per pupil is expressed as:

$$SEXP_i = AAOEP_i + CAID_i$$

where

$SEXP_i$ = simulated expenditures per pupil in the i^{th} school district

$AAOEP_i$ = approved operating expenditures per pupil in i^{th} school district, adjusted for some displacement of local revenue

$CAID_i$ = the change in the amount of aid received under the new aid program versus the old aid program in the i^{th} school district

These dollar figures are then adjusted by the cost of education index before being printed in the following tables. Due to this adjustment, comparison of changes in expenditures versus changes in state aid in Tables B-1 and B-2 do not appear consistent. The simulation in Table B-2 assumes that districts spend all of their aid increases; the columns of changes in expenditure and aid should be identical. The cost index has been used to adjust expenditures, however, and this column of data is slightly less for districts in the higher expenditure deciles. These tend to be high cost districts. Similarly the changes in expenditures in Table B-2 are not exactly one-half the changes in state aid.

Each simulation uses the simple assumptions or fiscal response equations described earlier; the specifics for each simulation table are described in Table 2.

The tables present summary output for each of the fiscal response/simulation models. The parameters of the aid program

Table 2
Guide to Fiscal Response Simulations

Fiscal Response Model	Appendix A Table	Appendix B Table
Simple assumption of all expenditure increase	NA	B-1
Simple assumption of one-half expenditure increase	NA	B-2
Nominal dollar analysis	A-1	B-3, B-4 and B-5
Real dollar analysis	A-2	B-6
Real dollar analysis including municipal overburden	A-3	B-7
Nominal dollar analysis using pooled data	A-4	B-8
Nominal dollar analysis using Wisconsin price response*	A-5	B-9

NA = Not applicable. Statistical equations not used in simulation.

*This simply means that the coefficient on the price variable in the total revenue equation is changed from −.33 to −.21; where −.31 is the coefficient from the Wisconsin total revenue equations.

are defined at the top of each table. The simulated level of expenditures per pupil, changes in real levels of those expenditures, and simulated levels and changes of actual aid are presented by deciles of expenditures per pupil. These deciles are approximately equal in the number of total pupils represented. The average income per return and full value of property for the districts falling into each decile is also printed. Finally, the equity measures for each distribution of simulated expenditures are displayed at the bottom side of each table.

Table B-1
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Expenditures per Pupil for 1979-80 and Summary Statistics, Assuming All Expenditure Increase

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,412	88	1,022	88	14,212	41,823
Second	1,532	59	944	59	15,312	45,510
Third	1,590	93	959	94	14,662	45,843
Fourth	1,650	81	907	77	14,618	49,783
Fifth	1,743	138	935	150	15,078	51,710
Sixth	1,844	197	946	205	14,753	51,337
Seventh	1,942	132	819	141	16,510	60,877
Eighth	2,048	172	833	184	16,851	61,934
Ninth	2,192	242	1,011	274	16,481	62,261
Tenth	2,522	229	856	250	20,939	86,037
AVERAGES						
New York City	1,761	294	996	350	14,013	62,245
Rest of State	1,846	143	923	152	15,928	55,643
Statewide	1,818	192	947	216	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.15
Income elasticity	.30

Equity Measures

Spending Gap (90th − 10th percentile)	$ 659
Coefficient of variation	.15

Cost to State

Additional dollars of aid	$ 876
State share	53.1
Local share	46.9

Table B-2
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Expenditures per Pupil for 1979-80 and Summary Statistics, Assuming One-Half Expenditure Increase

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		Stats Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,361	60	1,057	121	13,614	40,870
Second	1,475	75	1,044	153	13,740	41,775
Third	1,540	61	1,005	126	14,411	44,466
Fourth	1,608	67	1,010	143	14,878	43,768
Fifth	1,678	70	927	145	15,081	50,759
Sixth	1,761	55	845	114	15,390	57,234
Seventh	1,849	94	858	202	15,687	59,427
Eighth	1,953	125	1,017	281	16,231	55,862
Ninth	2,074	76	806	164	17,812	65,128
Tenth	2,458	30	656	68	22,520	97,986
AVERAGES						
New York City	1,614	147	996	350	14,013	62,245
Rest of State	1,774	71	923	152	15,928	55,643
Statewide	1,722	96	947	216	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.19
Income elasticity	.43

Cost to State

Additional dollars of aid	$ 816
State share	50.4
Local share	49.6

Equity Measures

Spending Gap (90th − 10th percentile)	$586
Coefficient of variation	.16

Table B-3
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Expenditures per Pupil for 1979-80 and Summary Statistics, Using Nominal Dollar Fiscal Response Estimates

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,416	108	1,012	117	13,809	44,407
Second	1,519	104	1,015	134	14,531	42,691
Third	1,579	86	997	107	14,049	44,457
Fourth	1,662	80	902	134	14,840	53,007
Fifth	1,748	60	826	122	15,841	59,529
Sixth	1,824	142	975	229	16,218	52,615
Seventh	1,937	220	1,081	331	14,804	53,319
Eighth	2,029	173	986	280	16,875	57,001
Ninth	2,177	199	985	298	16,933	66,225
Tenth	2,553	225	983	301	21,530	83,895
AVERAGES						
New York City	1,636	170	1,053	407	14,013	62,245
Rest of State	1,843	140	977	205	15,928	55,643
Statewide	1,776	150	1,002	271	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.12
Income elasticity	.35

Equity Measures

Spending Gap (90th − 10th percentile)	$690
Coefficient of variation	.17

Cost to State

Additional dollars of aid	$1,135
State share	51.7
Local share	48.3

Table B-4
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Gross Income per Return for 1979-80 and Summary Statistics, Using Nominal Dollar Fiscal Response Estimates

Deciles of Gross Income per Return	Gross Income per Return	Expenditures per Pupil		State Aid per Pupil		Full Value per Pupil
		Simulated	Change From 1979-80	Simulated	Change From 1979-80	
First	11,581	1,824	316	1,280	398	44,208
Second	12,440	1,721	212	1,138	304	45,678
Third	13,076	1,731	223	1,145	316	43,746
Fourth	13,785	1,793	289	1,269	411	45,654
Fifth	14,475	1,794	208	1,141	336	51,040
Sixth	15,350	1,824	191	1,089	355	53,007
Seventh	16,218	1,909	154	1,076	262	51,761
Eighth	17,678	1,894	72	890	129	57,740
Ninth	19,154	1,930	−19	605	−67	72,098
Tenth	25,688	2,232	−31	413	−110	91,987
AVERAGES						
New York City	14,013	1,649	183	1,076	430	62,245
Rest of State	15,928	1,865	162	1,006	235	55,643
Statewide	15,304	1,795	169	1,029	298	57,795

Wealth Neutrality Measures

Wealth elasticity	.12
Income elasticity	.35

Equity Measures

Spending Gap (90th − 10th percentile)	$690
Coefficient of variation	.17

Cost to State

Additional dollars of aid	$1,135
State share	51.7
Local share	48.3

Table B-5
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Full Value per Pupil for 1979-80, Using Nominal Dollar Fiscal-Response Estimates

Deciles of Full Value per Pupil	Full Value per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return
		Simulated	Change From 1979-80	Simulated	Change From 1979-80	
First	28,009	1,903	415	1,561	523	13,179
Second	34,901	1,741	246	1,308	324	13,770
Third	38,882	1,798	301	1,319	412	13,835
Fourth	41,606	1,762	211	1,200	311	14,920
Fifth	45,992	1,750	170	1,095	253	15,050
Sixth	50,877	1,899	218	1,091	350	14,709
Seventh	55,938	1,861	63	871	121	17,280
Eighth	64,627	1,806	21	688	63	16,839
Ninth	76,469	1,874	−22	505	−8	17,676
Tenth	121,704	2,266	−18	383	−29	22,375
AVERAGES						
New York City	62,245	1,649	183	1,076	430	14,013
Rest of State	55,643	1,865	162	1,006	235	15,928
Statewide	57,795	1,795	169	1,029	298	15,304

Wealth Neutrality Measures

Wealth elasticity	.12
Income elasticity	.35

Equity Measures

Spending Gap (90th − 10th percentile)	$690
Coefficient of variation	.17

Cost to State

Additional dollars of aid	$1,125
State share	51.7
Local share	48.3

Table B-6
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Gross Income per Return for 1979-80 and Summary Statistics, Using Real Dollar Fiscal Response Estimates

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,406	94	983	137	13,872	46,992
Second	1,503	89	1,049	129	13,914	40,940
Third	1,558	53	997	155	14,143	47,095
Fourth	1,638	62	902	98	15,160	49,978
Fifth	1,739	59	85?	141	15,833	50,350
Sixth	1,815	124	99(	269	16,114	54,002
Seventh	1,936	127	1,002	275	16,228	57,447
Eighth	2,038	248	1,140	398	16,017	55,663
Ninth	2,189	220	1,032	334	16,808	63,130
Tenth	2,594	302	1,106	408	21,240	81,791
AVERAGES						
New York City	1,622	156	1,064	418	14,013	62,245
Rest of State	1,840	137	1,006	234	15,928	55,643
Statewide	1,769	143	1,024	294	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.12
Income elasticity	.38

Equity Measures

Spending Gap (90th − 10th percentile)	$674
Coefficient of variation	.17

Cost to State

Additional dollars of aid	$1,108
State share	52.3
Local share	47.8

Table B-7
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Expenditures per Pupil for 1979-80 and Summary Statistics on Equity, Using Real Dollar and Including Municipal Overburden Fiscal Response Estimates

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,413	106	1,008	122	13,765	45,016
Second	1,516	101	1,021	133	14,433	42,242
Third	1,576	78	990	108	14,235	45,541
Fourth	1,657	70	881	134	14,694	54,084
Fifth	1,763	69	851	134	15,991	58,103
Sixth	1,847	164	1,014	278	16,209	53,813
Seventh	1,970	133	947	229	16,668	59,364
Eighth	2,073	281	1,117	415	15,730	58,149
Ninth	2,212	262	1,108	370	16,581	59,880
Tenth	2,612	334	1,136	434	21,030	80,504
AVERAGES						
New York City	1,643	177	1,068	422	14,013	62,245
Rest of State	1,863	160	1,007	236	15,928	55,643
Statewide	1,791	165	1,027	296	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.12
Income elasticity	.36

Equity Measures

Spending Gap (90th − 10th percentile)	$683
Coefficient of variation	.17

Cost to State

Additional dollars of aid	$1,117
State share	51.7
Local share	48.3

Table B-8
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Expenditures per Pupil for 1979-80 and Summary Statistics, Using Nominal Dollar Analysis on Pooled Data

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,423	107	1,008	105	14,030	44,002
Second	1,529	120	1,034	139	14,139	42,016
Third	1,586	94	993	113	14,246	44,584
Fourth	1,677	88	874	89	15,062	53,306
Fifth	1,771	79	814	142	15,915	60,854
Sixth	1,848	165	976	229	16,246	52,922
Seventh	1,969	234	1,051	318	15,196	55,191
Eighth	2,058	219	1,022	314	16,304	56,973
Ninth	2,202	210	979	280	16,936	65,113
Tenth	2,576	278	1,036	349	21,298	82,129
AVERAGES						
New York City	1,680	213	1,051	405	14,013	62,245
Rest of State	1,862	159	979	208	15,928	55,643
Statewide	1,803	177	1,003	272	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.13
Income elasticity	.35

Equity Measures

Spending Gap (90th − 10th percentile)	$879
Coefficient of [illegible]ation	.16

Cost to State

Additional dollars of aid	$1,035
State share	50.2
Local share	49.8

Table B-9
Simulated Expenditures, State Aid, Wealth and Income by Deciles of Expenditures per Pupil for 1979-80 and Summary Statistics, Using Nominal Dollar Fiscal Response and Wisconsin Price Estimate

Deciles of Simulated Expenditures per Pupil	Expenditures per Pupil		State Aid per Pupil		Gross Income per Return	Full Value per Pupil
	Simulated	Change From 1979-80	Simulated	Change From 1979-80		
First	1,416	108	1,012	117	13,809	44,407
Second	1,520	102	1,017	131	14,483	42,534
Third	1,583	91	1,000	114	14,087	44,668
Fourth	1,667	75	867	132	14,764	55,422
Fifth	1,762	59	824	113	16,204	59,308
Sixth	1,850	175	1,021	280	16,256	53,161
Seventh	1,972	143	967	254	16,474	58,976
Eighth	2,070	264	1,075	376	15,768	58,253
Ninth	2,212	279	1,145	390	16,429	58,550
Tenth	2,610	329	1,132	439	21,039	81,507
AVERAGES						
New York City	1,649	183	1,076	430	14,013	62,245
Rest of State	1,865	162	1,006	235	15,928	55,643
Statewide	1,795	169	1,029	298	15,304	57,795

Wealth Neutrality Measures

Wealth elasticity	.13
Income elasticity	.37

Equity Measures

Spending Gap (90th − 10th percentile)	$652
Coefficient of variation	.16

Cost to State

Additional dollars of aid	$1,022
State share	49.1
Local share	50.9

Appendix C
Glossary of Terms

Coefficient of Variation The coefficient of variation is a summary statistic that describes the amount of dispersion within a distribution. It is defined as the standard deviation divided by the mean of the distribution.

Expenditure Gap A measure of the range in expenditures per pupil across school districts, expressed in dollars of per pupil expenditures. For this report, the measure is the difference in the expenditures of the district at the 90th percentile and the district at the 10th percentile of expenditure per pupil.

Elasticity A measure of responsiveness. An elasticity is the percentage change in one variable in response to a one percent change in another variable; a direction of causation is implied.

Fiscal Response The change in taxation, and therefore spending, decisions by school districts in response to changes in economic factors.

Income Effect The effect of the state providing more money to a school district which increases the income available for school expenditures. A state aid program that provides a set amount of money to the district (e.g., a Foundation program) has an income effect.

Income Elasticity A measure of the relationship of per pupil expenditures and district income, expressed in percentage terms. A one percent change in the level of district income is associated with a certain percentage change in the level of expenditures per pupil.

Matching Rate The ratio of state aid dollars to the total number of dollars spent by the school district; this is the state's share of the district's expenditure.

Nominal Dollars Nominal dollars refer to actual dollars. That is, they are unadjusted for variations in the cost-of-living or cost-of-education input prices.

Price Effect The effect of the state sharing in the expenditures of the school district is a reduction in the price, in terms of taxes the district collects, to spend an extra dollar on education. A state aid formula that shares expenditures (e.g., a GTB program) has a price effect.

Price Elasticity — A measure of the relationship of per pupil expenditures and the price inherent in the school aid formula, expressed in percentage terms. A one percent change in this price variable is associated with a certain percentage change in the level of expenditures per pupil.

Real Dollars — Real dollars refer to dollar amounts that are adjusted to reflect differences in purchasing power. That is, they are divided by an index that reflects variations in either costs-of-living or costs-of-education inputs.

Statistically Significant — A relationship between two variables is statistically significant if the probability of the relationship being nonzero in repeated experiments is greater than a chosen percentage level. For this report, the relationship is considered significant if the probability exceeds 90 percent.

Wealth Elasticity — A measure of the relationship of per pupil expenditures and district property wealth, expressed in percentage terms. A one percent change in the level of district property wealth is associated with a certain percentage change in the level of expenditures per pupil.

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